Newton’s Second Law of Motion Lab — The Inertial Balance

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Background:**

Read the attached background and summarize for your lab

**Hypothesis:**

If we measure the period of oscillation of an object of known mass in an inertial balance, we will be able to determine the mass of an unknown object without the use of gravity.

**Variables:**

Independent: The trial masses (100g, 150g and 200g)

Dependent variable: The periods of three trial masses

Controlled variable: The same inertial balance was used for each trial

**Materials:**

Inertial balance**,** objects of unknown mass; Data table ; Graph paper, ruler, and pencil; 50, 100 and 200 gram brass weights; Large rubber bands; C-clamp; Stopwatch

**Procedure**

1. Read the attached material about inertial balances.   
2. View the video of how astronauts “weigh” themselves in space: <https://www.youtube.com/watch?v=8rt3udip7l4>  
3. Attach the inertial balance to the edge of your desk using a C clamp.  
4. Using the thick rubber bands, attach a 100 gram weight to the balance.  
**NOTE: Be sure to attach your weight securely to the outside of the balance. If your weight moves back and forth on the balance, you will affect the accuracy of your timing.**   
5. Push or pull the balance to one side and allow it to oscillate.  
6. Find the time for 10 cycles. Repeat three times.  
7. Add an additional 50 grams to the balance and retime  
8. Increase the mass in the balance to 200 grams and retime.  
9. Place a mass of unknown mass into the balance and repeat the procedure for ten oscillations  
10. Put your data into the data table below and find the average for all ten oscillations and then divide by ten to find the period of one oscillation.  
11. Use your graph to plot mass on the y axis and period on the x axis for the three weights.  
12. Do not include the period for the unknown.  
13. Create a “line of best fit” through the three points that you created.  
14. Find the period of oscillation for your unknown on the x axis and project it onto your graph.  
15. Read where this point intersects the y axis. This is your estimated mass of the unknown  
16. Use a triple beam balance to find the real mass of your unknown.  
17. Calculate a percent error of your unknown with your value against the real mass.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Mass added to the balance** | **Time for 10**  **Oscillations 1** | **Time for 10**  **Oscillations 2** | **Time for 10**  **Oscillations 4** | **Average Time**  **For ten Oscillations** | **Average Time**  **For one Oscillation** |
| **100 grams** |  |  |  |  |  |
|  |  |  |  |  |  |
| **150 grams** |  |  |  |  |  |
|  |  |  |  |  |  |
| **200 grams** |  |  |  |  |  |

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Wrap up questions:

1. How do you know that the inertial balance does not use gravity to measure mass?

2. How is this lab related to Newton’s Second Law

3. Were your sources of error systematic or random?

A. Systematic errors (these errors show consistency in measurement, e.g. all times were too short or all observations undercounted the swings)   
 1. Instrumental (calibration,)  
 2. Observational: (counting oscillations, timing)  
 3. Environmental (any changes to the atmosphere etc. which would effect your results)

B. Random errors (these errors were not consistent in their values, sometimes they were high, sometimes they were low.

4. How close were your values on your graph to a straight line? (Attach your graph to this lab)

5. How did inertia play a role in determining the mass of the unknown?

6. How do you think that the length of the inertial balance affects the period? Hint: think of the pendulum lab